straight specimen seen; and *d*, shortest *capitate* specimen seen, each about 1-300th inch long. Teeth directed *inwards*.

Fig. 5. The same. Capitate spined spicule of the cone and root, about 1-36th inch long. *a*, smooth, sharp-pointed, or proximal end; *b*, spined and capitate or distal end. Teeth recurved.

Fig. 6. The same. Diagram of four radial-chamber vents, to show the sarcodic sphincters in them respectively. *a*, vent; *b*, sarcodic sphincter.

Fig. 7. The same. Diagram of seven cones, to show the position of the pores in the triangular spaces between them. *a*, cone; *b*, pore.

Fig. 8. Sand-grains of the rock on which the variety has grown.

XIX.—*Some Preliminary Remarks on the Gemmules of the Freshwater Sponges.* By Dr. William Marshall*.

The gemmules of the freshwater sponges, as is well known, present in the constitution of their envelopes a series of very remarkable peculiarities, which are very different according to the species, and which, as adaptations, must have very special causes and significations.

Each germ possesses, according to the species, a round or oval, sometimes convexo-concave shell, furnished with one opening, or (in *Spongilla multiforis*, Cart.) with one principal and several subordinate apertures, through which the mature contents issue at the proper time. The innermost layer of this shell is a firm structureless membrane, which Carter † describes as chitinous ("*chitinous coat*"), by which, no doubt, is meant only that it is "horny," without reference to its chemical constitution.

In some few kinds of gemmules this innermost simple thin layer is alone present; in others the wall is thicker, and appears sometimes very peculiarly modified. Thus in *Spongilla nitens* (according to Carter's ‡ and my own observations) and in *S. Carteri* (according to Carter) we see that the thick capsule is not homogeneous, nor does it show that constitution which Carter calls "granular cell-structure." Under a low power it appears in section to be finely striated radially, and its surface, like that of the eye of an insect, appears divided up into elegant convex equilateral hexagons; by the employment of higher powers we discover that the lines of striation are not the expression of hexagonal corneous pyramids di-

* Translated by W. S. Dallas, F.L.S., from the 'Zoologischer Anzeiger,' 1883, pp. 630-634 and 648-652.

† Ann. & Mag. Nat. Hist. ser. 5, vol. vii. p. 83.

‡ *Loc. cit.*

minishing centripetally, but that they appear zigzagged and always so that in two neighbouring lines the opposite angles of the zigzag have their apices either turned towards or away from each other; and at the same time it is observed that the angles of two horny lamellæ which are turned towards one another are united by transverse floors; in other words the entire capsule of the gemmule consists of a system of little compartments inserted into each other in accordance with the three dimensions of space, and gradually diminishing in the thickness of their walls and in their dimensions from without inwards. The superficial compartments are hollow, and in the dry state, which alone we have here to take into consideration, filled with air; the innermost are solid; their form is that of a hexagonal prism terminated at each end with six faces, the longitudinal diameter of which lies tangentially to the sphere of the contents of the gemmule. These compartments are certainly not modified cells, but, like the innermost independent horny layer of the whole capsule, a cuticular formation. Their substance is structureless and very strongly refractive; it resists calcination remarkably, becomes brown without shrivelling, and during this process only the angle-lines stand forth strongly, especially of the angles of the compartments in which several walls meet together from different sides. Hydrofluoric acid has a peculiar effect upon this substance; by treatment therewith it loses its strong refractive power and also somewhat of its yellowish colour, and especially its brittleness, for which reason in gemmules treated with hydrofluoric acid we see the radial lines of contact of the compartment-columns brought much closer together, and the compartments, often enlarged in a radial direction, in general, but especially in the peripheral layers, much more irregular in form. Hence it seems to me not improbable that a strong percentage of silica is proper to this substance. Externally and internally the compartment-layer of the capsule is surrounded by a system of tangentially-placed but otherwise irregularly-arranged siliceous spicules, beset at both ends, even as far as the middle, with fine spinules curved inwards. The spicules adhere more firmly to the inner surface of the compartment-layer than to the outer surface of the firmer horny layer in immediate contact with the germ, which exhibits a fine concentric striation, and on the outside fine irregularly-placed pits, the impressions of the spinules of the inner tangential spicules. This is easily seen in sections through the gemmules, in which the inner layer readily separates from the compartment-layer.

The aperture of exit for the germ when awakened to life is round, and passes through both layers of the wall; but it

is furnished with a remarkable closing-apparatus, as Carter figures it in a gemmule of *S. Carteri*, Bow. The envelope immediately surrounding the inner germ separates at one spot in such a manner as to form a globular hollow space, the outer wall of which projects somewhat beyond the outer surface of the compartment-layer, in the thickness of which the cavity is situated; therefore this alone is penetrated. If the dry gemmules be thrown into water they float with this capsule upwards, so that its surface remains out of the water. It is only after from eight to ten days that they begin to sink; and if, as is probable, this is the case also with the living gemmules, the germs will only then awaken. This closing-vesicle seems to me to be a hydrostatic apparatus; and that it maintains the gemmules so long at the surface of the water is perhaps not without significance, for if they are carried by the wind into shallow pools, which the power of the sun would soon dry up, their contents will not issue forth before the evaporation occurs, and will thus, by the delay that takes place, escape destruction.

The formation of the germ-capsule will very probably take place as follows :—the portion of the parent animal separated as a germ first of all itself secretes on its surface a horny covering in layers (whence the concentric striation) as a cuticular formation; to this is then applied from without a system of tangential spicules; and upon this again, as a cuticular formation of the parent organism, the compartment-layer, which is finally coated by the external system of tangential spicules. The germ, which, as in all *Spongillæ*, consists in the dry state for by far the greater part of starch-corpuscles (probably reserve nutritive material), as already described and figured by Carter, is in this way admirably protected, but at the same time also in other respects most advantageously endowed.

The gemmules in *S. nitens* are remarkably small (as also in *S. Carteri*), and therefore light, and all the lighter because the comparatively thick enveloping capsule contains such numerous cavities. The importance of this remarkable architecture of the capsule in my opinion lies in this, that by it the gemmules will find the widest possible distribution under the circumstances in which the stock or parent *Spongilla* appears to exist—the light capsule enclosing air-spaces acts as an aerostatic apparatus!

The *Spongillæ* in question which break up into such gemmules are inhabitants of hot countries; they will frequently be liable, under the influence of the glowing sun, to be laid dry : most of them when this happens will die away; but they live on in the parts of themselves in the protected gemmules,

which precisely in these species escape very easily from the dead *Spongilla*, with which they are not in the least united. The wind will take them up, scatter them here and there over the great plains of Africa &c., and deposit them in dried-up watercourses, in which they will be found by the vivifying element at the commencement of the rainy season. This is not contradicted by the fact that others come to rest in perennial fresh waters and develop there; many will be carried far away to islands and from land to land, many will get into the sea and never fulfil their destiny; but if, out of their great number, the greater because they are so small, only a very small percentage arrives at development, the preservation of the species is thereby abundantly assured.

What a means of transport for organic substances the wind is we may learn from the works of the honoured master Ehrenberg; out of the 1200 figures which he gives of organisms obtained from samples of dust carried by the trade-winds, no fewer than 285, or, in round numbers, 24 per cent., are evidently remains of sponges; and of these 46, or, in round numbers, 4 per cent. of the whole, or nearly 16 per cent. of the sponge-fragments, are fractured or entire amphidisci of various species of *Spongillæ*.

By far the greater part of the organic remains figured by Ehrenberg are derived from fresh water: we find among them Diatomeæ still with green contents rich in chlorophyll; the marine objects, Polythalamia, sponge-spicules (some of which are of deep-water forms, such as Geodiæ and Hexactinellidæ), are probably not, as Ehrenberg supposed, recent, but originate from the Tertiary deposits of North-west Africa (Oran), which contain such an abundance of fossils. That among this dust, which therefore originates from Africa, and not, as Ehrenberg supposed, from South America, to be thrown down in Europe, there are no such large specimens as the gemmules of *Spongilla nitens* for example, proves scarcely any thing. The further the particles of dust are carried from the regions in which they were taken up, the finer will they be, and *vice versâ*. According to the weight of the objects transported a sort of sifting of the atmosphere will gradually take place!

I have experimented, certainly with the roughest apparatus, in the following manner:—a number of gemmules from specimens of *Spongilla lacustris* and *S. nitens* (from the White Nile, in the Leipzig Museum), which had already been preserved dry for many years, were further dried at a moderate heat under the same conditions for eight days; then fifty of each kind were taken and mixed together, and then placed in a little heap at one end of a perfectly flat newly polished

table. Towards this little heap a very moderate horizontal current of air (the force of which, however, I had no means of measuring) was then directed by means of a pair of small hand-bellows, and this immediately caused its dispersal. This proceeding was repeated six times, and each time after the dispersion of the gemmules a pair of compasses was set in the middle of the spot where the little heap had been; its legs were gradually opened at intervals of 1 centimetre, and curves were drawn upon the table. In this way were obtained ten curved regions each of 1 centimetre broad, and in these the gemmules were counted; then the mean of the six observed cases was taken and multiplied by two, in order to bring it to a percentage for each kind of gemmule. The following was the result:—

Regions of 1 centim. broad.	1	2	3	4	5	6	7	8	9	10 and more.	Total.
Gemmules of *Sp. lacustris.*	5	9	7	17	26	16	11	7	2	..	100
Gemmules of *Sp. nitens.*	1	2	..	9	13	22	27	13	9	4	100

These experiments, I readily admit, are very rough, but they do not seem to me to be absolutely valueless: this much, at any rate, may be learned from them, that the moving power of the wind acts more powerfully upon the gemmules of *Spongilla nitens* than upon those of *S. lacustris*; and to ascertain this was the purpose of the experiments.

The gemmules of the other freshwater sponges* usually differ considerably from those of *Spongilla nitens* and *Carteri*. In no freshwater sponge known to me is the connexion of the gemmules with the rest of the body so intimate as in *Parmula Brownii*, Bow., of which I have been able to examine three specimens from the Rio Negro, most kindly presented to the Leipzig Museum by Dr. Carl Müller-Halle. Each gemmule, with its shell, is surrounded by a special capsule, which is never provided with an aperture, and which contains a very small quantity of horny substance, but is formed chiefly of naviculiform spicules, lying close together, like cobble-

* I have been unable to compare those of the genus *Tubella*, Carter, and of the remarkable new North-American forms.

stones, in such a manner that their convex sides are directed outwards. These spicules are not quite irregularly arranged; they have a tendency to radiate from certain points in a stellate arrangement, and, on close examination, for example in sections, we observe that at these points the inner surface of the capsule is in contact with the true envelope of the gemmule. The latter, in fact, is not uniformly smooth, but furnished with numerous, irregularly distributed, conical prominences, which pass to the inner surface of the exterior capsule, but are only loosely connected therewith. If the gemmules are allowed to swell up in warm water within the capsules, which is a rather long operation, it is seen that in course of time the exterior capsules are first ruptured at these points of contact. This may also occur normally when the capsule with its still living contents has again got under water; as the capsule has not, like the true gemmule-envelope, a special aperture of issue, the germ, newly awakened into life, could hardly otherwise be set free.

The true envelope of the gemmule is not thick, shows a simple granular structure, and is only covered superficially with round siliceous shields, which, on the outside, rise into short spiniform knobs and are slightly hollowed within. These shields lie so closely over the whole surface that their margins overlap; only the conical prominences are quite free from them. Their margins are imbedded in the base-substance of the envelope, while their little points are exposed. The round exit-aperture for the germ is here furnished with a closing apparatus.

The significance of this complicated investiture of the gemmules of *Parmula* is not hard to understand. The exterior capsule, as Carter has already pointed out, is composed of true skeletal elements specially modified. These naviculiform spicules exactly resemble those with which the stronger trains of spicules of the framework of the sponge are coated; the capsules usually pass into this coating, and are continuously connected with it; frequently also two or more capsules are intimately united by bridges of such spicules, as Bowerbank has already shown in his figures. It is clear that in this way the gemmules are very firmly attached to the rest of the framework; and it often happens that, when one wishes to separate such a gemmule-capsule from the dried sponge with the forceps, a portion of the adhering spicule-train of the skeleton is broken away with it. This intimate union is certainly of some importance to the gemmule, and I believe that we come upon the track of it if we consider the mode of life of the species of *Parmula*. Bates mentions that *Spongilla*

Batesii occurs upon the twigs and stems of trees which are under water during the months of the rainy season; and Carl Müller* states, from the reports of the traveller Gustav Wallis, who also met with this sponge, called in its native country "Canixi" (pron. Canischi), that the sponge appears especially to be produced where air can act upon it—that is, upon *stones which are alternately wet and dry during the rising and sinking of the stream.* By means of the spicular capsules the gemmules are firmly affixed to the dried sponge, so that they cannot fall out and perish on the dry ground; but when, in the rainy season, the rising water again reaches the sponges of the previous year, the capsules are ruptured (as may be artificially shown), and the true gemmules are set free and can become developed in the water. The armature of siliceous shields seems to prevent too great a collapse of the delicate gemmule-envelopes during desiccation; as their margins overlap the conditions are similar to those of a coat of scale-armour, which also is only compressible to a certain extent. When I removed the siliceous structures by hydrofluoric acid the envelopes became very flexible. The amphidisci of the gemmule-envelopes of the *Meyeniæ* seem to have a similar function, but a double disk would not be necessary for this purpose; this, as we shall see immediately, has been produced by another adaptation.

The gemmules of the series of forms to which *Spongilla lacustris* belongs have homogeneous membranous walls provided at the surface with projecting, often spinose, tangential or radiating spicules; hence they are certainly heavier than the gemmules of the *nitens* series, but at the same time always light enough to be able to swim in and upon the water. The superficial spicules, like the uncinate processes of many statoblasts of Bryozoa, will act as adherent organs, by which the gemmules may on occasion be anchored. This constitution of the gemmules is certainly advantageous to forms of *Spongillæ* which live in stagnant or slowly flowing water, but would be of doubtful advantage to those dwelling in brooks and rivers with strong currents; here, being continually rolled and driven along, they would have few chances of coming to rest, and a large percentage would be lost. To prevent this the gemmule would have to adopt, as it were, a check in the form of a heavier shell; and this is effected by the introduction of special siliceous elements, the amphidisci, which at the same time form a shield against the occasional shocks and contusions which are inevitable in running water,

* See 'Die Natur,' Bd. xxiii. (1870), p. 181.

especially with a stony bottom. The gemmules of the *fluviatilis*-series are heavier than those of the *lacustris*-series, as one may easily convince one's self by scattering the two upon water; the *fluviatilis*-gemmules sink much sooner than those of *lacustris*. By moving water they will be rolled along slowly, and especially at the bottom.

It would appear that the *Meyeniæ* are chiefly distributed in running waters, while the true *Spongillæ* are rather inhabitants of still water. This, of course, does not mean that the two forms are sharply separated in this respect; on the contrary, *Meyeniæ* will easily be found in stagnant water, although true *Spongillæ* are not so readily met with in strongly running water.

A form of *Meyenia*, *M. mirabilis*, from the Ohlau, near Breslau, lately made known by Dr. Wilhelm Retzer*, is interesting in more than one respect; but especially on account of its gemmules, which have a triple armature of amphidisci one above the other. I do not know the character of the Ohlau (not Ohle) and its subsidiary waters, but probably its system includes many rapid brooks, so that the gemmules of the sponges occurring in it have had to adapt themselves in this direction.

I find it not inconceivable that, in the lapse of time, *Spongillæ* (*Euspongilla*, Vejd.) may become converted into *Meyeniæ* (*Ephydatia*, Lamx., Gray) by long residence in running water, *i. e.* that their skeletal elements, and especially their gemmule-envelopes, may become modified in this direction; and that, on the other hand, by a long undisturbed sojourn in standing water, *Meyeniæ* may revert to true *Spongillæ*, by the gradual loss of the amphidisci &c. From this point of view the *Euspongilla jordanensis*, var. *druliæformis*, recently described by Vejdovsky†, acquires a heightened interest. In it we have perhaps before us a *Meyenia* in process of reversion. In the siliceous elements of the shell of the gemmule drawn by Vejdovsky, in his pl. ii. fig. 19, we have before us a series of transitions from the amphidisci (*c*) to the simple disk (*e*). Moreover, these structures are much more sparingly scattered in the membrane of the gemmule (see pl. ii. fig. 14) than in the true *Meyeniæ*. I should not be at all surprised if, in course of time, in the quiet water of the pool of the Jordan, this siliceous armature were entirely to disappear—that is, supposing that no "new blood" was introduced from with-

* W. Retzer, "Die deutschen Süsswasserschwämme," Inaug. Diss. Tübingen, 1883, p. 25, pl. ii. fig. 13.

† Abhandl. d. kön. böhm. Gesellsch. d. Wiss. 6 Folge, Bd. xii. p. 22, Taf. ii. figs. 14–19.

out, producing intercrossings by sexual reproduction. That the gemmules of the new form are considerably smaller than is usual in *Spongilla* has little or nothing to do with the matter; the gemmules of *S. lacustris* vary very considerably in size in different localities, perhaps according to the size of the piece of water inhabited by the sponges, or that of the parent animal, but I can say nothing positive as to the cause of this phenomenon.

From what is above stated, we find the gemmules of the freshwater sponges adapted in the following manners:— 1. Passively locomotive with aerostatic apparatus, the flying form (of the dry season), *nitens* series; 2. Passively locomotive swimming form, with anchoring apparatus, for propulsion at the surface before the wind, *lacustris* series; 3. Swimming form, with check-apparatus for slow locomotion in running water, *fluviatilis* series; 4. Secured from desiccation by a double enclosure, adhering firmly to the body of the parent, and only arriving at development when the water, during the wet season, rises again to the level, genus *Parmula*, Cart.

Besides these there also exist freshwater sponges without gemmules:—*Lubomirskia* from Lake Baikal; the forms collected in the Congo by Dr. Pechuël-Lösche, forming a new genus, *Potamolepis*, a description of which, by myself, has lately appeared in the 'Jenaische Zeitschrift'*, and the subterranean *Spongilla stygia*, Joseph, from the Cave of Gurk, in Carniolia.

In conclusion, I repeat my previous request to all my fellow-labourers to be kind enough to aid me with material, accompanied by the most exact account of the localities (the nature of the water, whether moving or quiet, whether large or small, brook, river, old river-course, pool or lake; the nature of occasional affluences, whether exposed to desiccation, &c. It is necessary to know everything!). A great many gentlemen have most kindly complied with my former prayer, but for the solution of certain questions the material can hardly be large enough!

XX.—*On a new Genus of Butterfly from New Zealand.*

By Arthur G. Butler, F.L.S., F.Z.S., &c.

At a meeting of the Philosophical Institute of Canterbury, New Zealand, held on the 30th November, 1883, Mr. R. W. Fereday read the "Description of a Species of Butterfly new

* See Ann. & Mag. Nat. Hist. ser. 5, vol. xii. p. 391, December 1883.